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**Pearson Edexcel GCE**

| Centre Number | Candidate Number |
|---|---|
| | |

# Core Mathematics C1

## Advanced Subsidiary

Wednesday 18 May 2016 – Morning
**Time: 1 hour 30 minutes**

Paper Reference
**6663/01**

**You must have:**
Mathematical Formulae and Statistical Tables (Pink)

Total Marks

**Calculators may NOT be used in this examination.**

## Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B). Coloured pencils and highlighter pens must not be used.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.

## Information

- The total mark for this paper is 75.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

## Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

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**1.** Find

$$\int \left(2x^4 - \frac{4}{\sqrt{x}} + 3\right) dx$$

giving each term in its simplest form.

**(4)**

**Q1**

**(Total 4 marks)**

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| Question Number | Scheme | Notes | Marks |
|---|---|---|---|
| **1** | $\int(2x^4 - \frac{4}{\sqrt{x}} + 3)\mathrm{d}x$ | | |
| | $\frac{2}{5}x^5 - \frac{4}{\frac{1}{2}}x^{\frac{1}{2}} + 3x$ | M1: $x^n \to x^{n+1}$. One power increased by 1 but not for just + $c$. This could be for 3 → $3x$ or for $x^n \to x^{n+1}$ on what they think $\frac{1}{\sqrt{x}}$ is as a power of $x$. | M1A1A1 |
| | | A1: One of these 3 terms correct. Allow un-simplified e.g. $\frac{2x^{4+1}}{4+1}$, $-\frac{4x^{-\frac{1}{2}+1}}{-\frac{1}{2}+1}$, $3x^1$ | |
| | | A1: Two of these 3 terms correct. Allow un-simplified e.g. $\frac{2x^{4+1}}{4+1}$, $-\frac{4x^{-\frac{1}{2}+1}}{-\frac{1}{2}+1}$, $3x^1$ | |
| | $= \frac{2}{5}x^5 - 8x^{\frac{1}{2}} + 3x + c$ | **Complete fully correct simplified expression appearing all on one line with constant**. Allow 0.4 for $\frac{2}{5}$. Do not allow $3x^1$ for $3x$. Allow $\sqrt{x}$ or $x^{0.5}$ for $x^{\frac{1}{2}}$ | A1 |
| | **Ignore any spurious integral signs and ignore subsequent working following a fully correct answer.** | | |
| | | | [4] |
| | | | **4 marks** |

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**2.** Express $9^{3x+1}$ in the form $3^y$, giving $y$ in the form $ax + b$, where $a$ and $b$ are constants.
**(2)**

Q2

**(Total 2 marks)**

| Question Number | Scheme | Notes | Marks |
|---|---|---|---|
| **2** | $9^{3x+1}$ = for example<br>$3^{2(3x+1)}$ or $\left(3^2\right)^{3x+1}$ or $\left(3^{(3x+1)}\right)^2$ or $3^{3x+1}\times 3^{3x+1}$<br>or $\left(3\times 3\right)^{3x+1}$ or $3^2\times\left(3^2\right)^{3x}$ or $\left(9^{\frac{1}{2}}\right)^y$ or $9^{\frac{1}{2}y}$<br>or $y = 2\left(3x+1\right)$ | Expresses $9^{3x+1}$ correctly as a power of 3 or expresses $3^y$ correctly as a power of 9 or expresses $y$ correctly in terms of $x$<br><br>(**This mark is <u>not</u> for just** $3^2 = 9$) | M1 |
| | $= 3^{6x+2}$ or $y = 6x + 2$ or $a = 6$, $b = 2$ | Cao (isw if necessary) | A1 |
| | Providing there is no incorrect work, allow sight of $6x + 2$ to score both marks<br>Correct answer only implies both marks<br>**Special case:** $3^{6x+1}$ **only** scores M1A0 | | |
| | | | [2] |
| | **Alternative using logs** | | |
| | $9^{3x+1} = 3^y \Rightarrow \log 9^{3x+1} = \log 3^y$ | | |
| | $\left(3x+1\right)\log 9 = y\log 3$ | Use power law correctly on both sides | M1 |
| | $y = \dfrac{\log 9}{\log 3}\left(3x+1\right)$ | | |
| | $y = 6x+2$ | cao | A1 |
| | | | **2 marks** |

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**3.** (a) Simplify

$$\sqrt{50} - \sqrt{18}$$

giving your answer in the form $a\sqrt{2}$, where $a$ is an integer.

**(2)**

(b) Hence, or otherwise, simplify

$$\frac{12\sqrt{3}}{\sqrt{50} - \sqrt{18}}$$

giving your answer in the form $b\sqrt{c}$, where $b$ and $c$ are integers and $b \neq 1$

**(3)**

| Question Number | Scheme | Notes | Marks |
|---|---|---|---|
| 3.(a) | $\sqrt{50}-\sqrt{18}=5\sqrt{2}-3\sqrt{2}$ | $\sqrt{50}=5\sqrt{2}$ or $\sqrt{18}=3\sqrt{2}$ **and** the other term in the form $k\sqrt{2}$. This mark may be implied by the correct answer $2\sqrt{2}$ | M1 |
| | $=2\sqrt{2}$ | Or $a=2$ | A1 |
| | | | **[2]** |
| (b) **WAY 1** | $\dfrac{12\sqrt{3}}{\sqrt{50}-\sqrt{18}}=\dfrac{12\sqrt{3}}{"2"\sqrt{2}}$ | Uses part (a) by replacing denominator by their $a\sqrt{2}$ where $a$ is numeric. This is all that is required for this mark. | M1 |
| | $=\dfrac{12\sqrt{3}}{"2"\sqrt{2}}\times\dfrac{\sqrt{2}}{\sqrt{2}}=\dfrac{12\sqrt{6}}{4}$ | Rationalises the denominator by a correct method e.g. multiplies numerator and denominator by $k\sqrt{2}$ to obtain a multiple of $\sqrt{6}$. Note that multiplying numerator and denominator by $2\sqrt{2}$ or $-2\sqrt{2}$ is quite common and is acceptable for this mark. May be implied by a correct answer. **This is dependent on the first M1.** | dM1 |
| | $=3\sqrt{6}$ or $b=3$, $c=6$ | Cao and cso | A1 |
| | | | **[3]** |
| **(b) WAY 2** | $\dfrac{12\sqrt{3}}{\sqrt{50}-\sqrt{18}}\times\dfrac{\sqrt{50}+\sqrt{18}}{\sqrt{50}+\sqrt{18}}$ **or** $\dfrac{12\sqrt{3}}{5\sqrt{2}-3\sqrt{2}}\times\dfrac{5\sqrt{2}+3\sqrt{2}}{5\sqrt{2}+3\sqrt{2}}$ | For rationalising the denominator by a correct method i.e. multiplying numerator and denominator by $k\left(\sqrt{50}+\sqrt{18}\right)$ | M1 |
| | $\dfrac{60\sqrt{6}+36\sqrt{6}}{50-18}$ | For replacing numerator by $\alpha\sqrt{6}+\beta\sqrt{6}$. **This is dependent on the first M1 and there is no need to consider the denominator for this mark.** | dM1 |
| | $=3\sqrt{6}$ or $b=3$, $c=6$ | Cao and cso | A1 |
| | | | **[3]** |
| **(b) WAY 3** | $\dfrac{12\sqrt{3}}{\sqrt{50}-\sqrt{18}}=\dfrac{12\sqrt{3}}{"2"\sqrt{2}}$ | Uses part (a) by replacing denominator by their $a\sqrt{2}$ where $a$ is numeric. This is all that is required for this mark. | M1 |
| | $=\dfrac{12\sqrt{3}}{2\sqrt{2}}=\dfrac{6\sqrt{3}}{\sqrt{2}}=\dfrac{\sqrt{108}}{\sqrt{2}}=\sqrt{54}=\sqrt{9}\sqrt{6}$ | Cancels to obtain a multiple of $\sqrt{6}$. **This is dependent on the first M1.** | dM1 |
| | $=3\sqrt{6}$ Or $b=3$, $c=6$ | Cao and cso | A1 |
| | | | **[3]** |
| **(b) WAY 4** | $\dfrac{12\sqrt{3}}{\sqrt{50}-\sqrt{18}}=\dfrac{12\sqrt{3}}{"2"\sqrt{2}}$ | Uses part (a) by replacing denominator by their $a\sqrt{2}$ where $a$ is numeric. This is all that is required for this mark. | M1 |
| | $\left(\dfrac{12\sqrt{3}}{"2"\sqrt{2}}\right)^2=\dfrac{432}{8}$ | | |
| | $\sqrt{54}=\sqrt{9}\sqrt{6}$ | Obtains a multiple of $\sqrt{6}$. **This is dependent on the first M1.** | dM1 |
| | $=3\sqrt{6}$ Or $b=3$, $c=6$ | Cao and cso (do not allow $\pm 3\sqrt{6}$ ) | A1 |
| | | | **5 marks** |

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**4.**

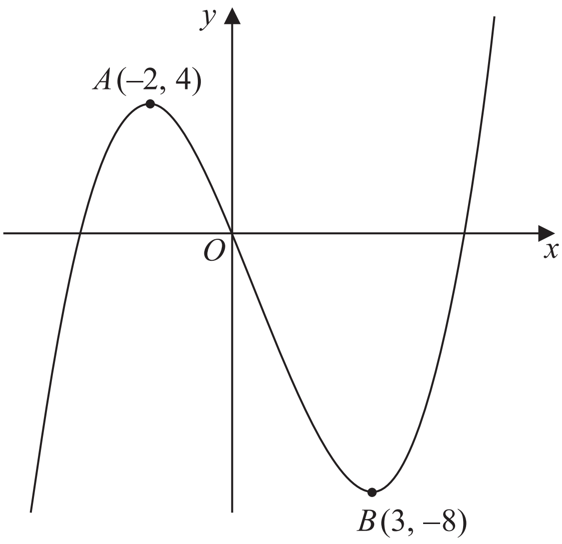



**Figure 1**

Figure 1 shows a sketch of part of the curve with equation $y = \mathrm{f}(x)$. The curve has a maximum point $A$ at (–2, 4) and a minimum point $B$ at (3, –8) and passes through the origin $O$.

On separate diagrams, sketch the curve with equation

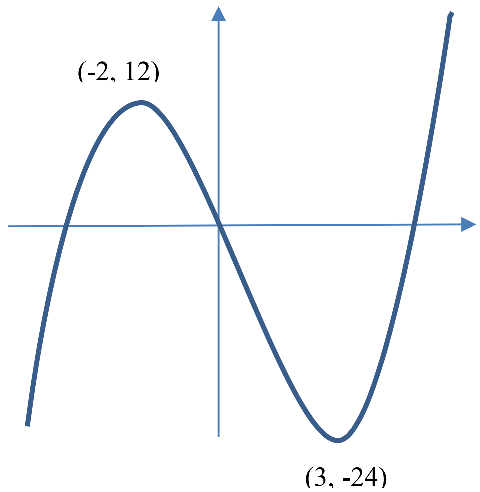
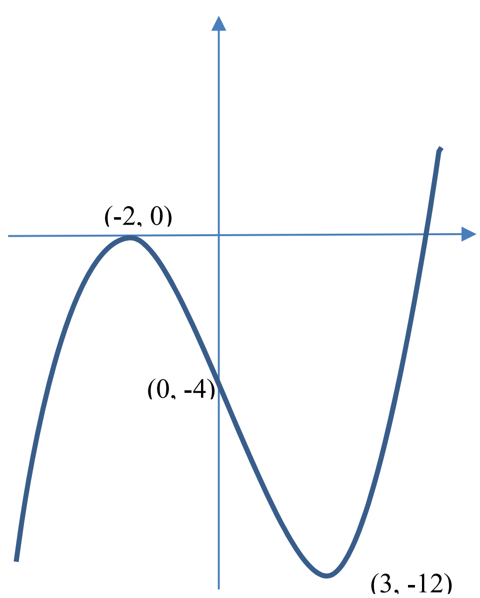
(a) $y = 3\mathrm{f}(x)$,

**(2)**

(b) $y = \mathrm{f}(x) - 4$

**(3)**

On each diagram, show clearly the coordinates of the maximum and the minimum points and the coordinates of the point where the curve crosses the $y$-axis.

| Question Number | Scheme | Notes | Marks |
|---|---|---|---|
| | Note original points are $A(-2, 4)$ and $B(3, -8)$ | | |
| **4.(a)** |  | Similar shape to given figure passing through the origin. A cubic shape with a maximum in the second quadrant and a minimum in the 4th quadrant. There must be evidence of a change in at least one of the *y*-coordinates (inconsistent changes in the y-coordinates are acceptable) but **not the *x*-coordinates**. | B1 |
| | | Maximum at (-2, 12) and minimum at (3, -24) with coordinates written the right way round. Condone missing brackets. The coordinates may appear on the sketch, or separately in the text (not necessarily referenced as *A* and *B*). If they are on the sketch, the *x* and *y* coordinates can be positioned correctly on the axes rather than given as coordinate pairs. In cases of ambiguity, the sketch has precedence. The origin does not need to be labelled. Nor do the *x* and *y* axes. | B1 |
| | | | **[2]** |
| **(b)** |  | A positive cubic which does not pass through the origin with a maximum to the left of the *y*-axis and a minimum to the right of the *y*-axis. | M1 |
| | | Maximum at (-2, 0) and minimum at (3, -12). Condone missing brackets. For the max allow just -2 or (0, -2) if marked in the correct place. If the coordinates are in the text, they must appear as (-2, 0) and must not contradict the sketch. The curve must **touch** the *x*-axis at (-2, 0). For the min allow coordinates as shown or 3 and -12 to be marked in the correct places on the axes. In cases of ambiguity, the sketch has precedence. | A1 |
| | | Crosses *y*-axis at (0, -4). Allow just -4 (not +4) and allow (-4, 0) if marked in the correct place. If the coordinates are in the text, they must appear as (0, -4) and must not contradict the sketch. In cases of ambiguity, the sketch has precedence. | A1 |
| | | | **[3]** |
| | | | **5 marks** |

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5. Solve the simultaneous equations

$$y + 4x + 1 = 0$$

$$y^2 + 5x^2 + 2x = 0$$

**(6)**

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| Question Number | Scheme | Notes | Marks |
|---|---|---|---|
| | **WAY 1** | | |
| **5.** | $y = -4x - 1$ $\Rightarrow (-4x-1)^2 + 5x^2 + 2x = 0$ | Attempts to makes *y* the subject of the linear equation and substitutes into the other equation. Allow slips e.g. substituting *y* = -4*x* + 1 etc. | M1 |
| | $21x^2 + 10x + 1 = 0$ | Correct 3 term quadratic (terms do not need to be all on the same side). The "= 0" may be implied by subsequent work. | A1 |
| | $(7x+1)(3x+1) = 0 \Rightarrow (x =) -\frac{1}{7}, -\frac{1}{3}$ | dM1: Solves a **3 term** quadratic by the usual rules (see general guidance) to give at least one value for *x*. **Dependent on the first method mark.** A1: $(x =) -\frac{1}{7}, -\frac{1}{3}$ (two separate correct exact answers). Allow exact equivalents e.g. $(x =) -\frac{6}{42}, -\frac{14}{42}$ | dM1 A1 |
| | $y = -\frac{3}{7}, \frac{1}{3}$ | M1: Substitutes to find at least one *y* value (Allow substitution into their rearranged equation above but not into an equation that has not been seen earlier). You may need to check here if there is no working and *x* values are incorrect. A1: $y = -\frac{3}{7}, \frac{1}{3}$ (two correct exact answers) Allow exact equivalents e.g. $y = -\frac{18}{42}, \frac{14}{42}$ | M1 A1 |
| | **Coordinates do not need to be paired** | | |
| | **Note that if the linear equation is explicitly rearranged to *y* = 4*x* + 1, this gives the correct answers for *x* and possibly for *y*. In these cases, if it is not already lost, deduct the final A1.** | | |
| | | | **[6]** |
| | **WAY 2** | | |
| | $x = -\frac{1}{4}y - \frac{1}{4}$ $\Rightarrow y^2 + 5(-\frac{1}{4}y - \frac{1}{4})^2 + 2(-\frac{1}{4}y - \frac{1}{4}) = 0$ | Attempts to makes *x* the subject of the linear equation and substitutes into the other equation. Allow slips in the rearrangement as above. | M1 |
| | $\frac{21}{16}y^2 + \frac{1}{8}y - \frac{3}{16} = 0 \ \left(21y^2 + 2y - 3 = 0\right)$ | Correct 3 term quadratic (terms do not need to be all on the same side). The "= 0" may be implied by subsequent work. | A1 |
| | $(7y+3)(3y-1) = 0 \Rightarrow (y =) -\frac{3}{7}, \frac{1}{3}$ | dM1: Solves a **3 term** quadratic by the usual rules (see general guidance) to give at least one value for *y*. **Dependent on the first method mark.** A1: $(y =) -\frac{3}{7}, \frac{1}{3}$ (two separate correct exact answers). Allow exact equivalents e.g. $(y =) -\frac{18}{42}, \frac{14}{42}$ | dM1 A1 |
| | $x = -\frac{1}{7}, -\frac{1}{3}$ | M1: Substitutes to find at least one *x* value (Allow substitution into their rearranged equation above but not into an equation that has not been seen earlier). You may need to check here if there is no working and *y* values are incorrect. A1: $x = -\frac{1}{7}, -\frac{1}{3}$ (two correct exact answers) Allow exact equivalents e.g. $x = -\frac{6}{42}, -\frac{14}{42}$ | M1 A1 |
| | **Coordinates do not need to be paired** | | |
| | **Note that if the linear equation is explicitly rearranged to *x* = (y + 1)/4, this gives the correct answers for *y* and possibly for *x*. In these cases, if it is not already lost, deduct the final A1.** | | |
| | | | **[6]** |
| | | | **6 marks** |

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**6.** A sequence $a_1, a_2, a_3, \ldots$ is defined by

$$a_1 = 4,$$

$$a_{n+1} = 5 - ka_n, \quad n \geqslant 1$$

where $k$ is a constant.

(a) Write down expressions for $a_2$ and $a_3$ in terms of $k$.

**(2)**

Find

(b) $\sum_{r=1}^{3}(1 + a_r)$ in terms of $k$, giving your answer in its simplest form,

**(3)**

(c) $\sum_{r=1}^{100}(a_{r+1} + ka_r)$

**(1)**

| Question Number | Scheme | Notes | Marks |
|---|---|---|---|
| | $a_1 = 4,\ a_{n+1} = 5 - ka_n\ ,\ n \ldots 1$ | | |
| **6.** (a) | $a_2 = 5 - ka_1\ = 5 - 4k$<br>$a_3 = 5 - ka_2\ = 5 - k(5 - 4k)$ | M1: Uses the recurrence relation correctly at least once. This may be implied by $a_2 = 5 - 4k$ or by the use of $a_3 = 5 - k(\text{their } a_2)$<br>A1: Two correct expressions – need not be simplified but must be seen in (a).<br>Allow $a_2 = 5 - k4$ and $a_3 = 5 - 5k + k^2 4$<br>Isw if necessary for $a_3$. | M1A1 |
| | | | **[2]** |
| (b) | $\sum_{r=1}^{3}(1) = 1 + 1 + 1$ | Finds 1+1+1 or 3 somewhere in their solution (may be implied by e.g. $5 + 6 - 4k + 6 - 5k + 4k^2$). Note that $5 + 6 - 4k + 6 - 5k + 4k^2$ would score B1 and the M1 below. | B1 |
| | $\sum_{r=1}^{3} a_r = 4 + "5 - 4k" + "5 - 5k + 4k^2"$ | Adds 4 to their $a_2$ and their $a_3$ where $a_2$ and $a_3$ are functions of $k$. The statement as shown is sufficient. | M1 |
| | $\sum_{r=1}^{3}(1 + a_r) = 17 - 9k + 4k^2$ | Cao but condone '= 0' after the expression | A1 |
| | **Allow full marks in (b) for correct answer only** | | |
| | | | **[3]** |
| (c) | 500 | cao | B1 |
| | | | **[1]** |
| | | | **6 marks** |

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**7.** Given that

$$y = 3x^2 + 6x^{\frac{1}{3}} + \frac{2x^3 - 7}{3\sqrt{x}}, \quad x > 0$$

find $\dfrac{dy}{dx}$. Give each term in your answer in its simplified form.

**(6)**

| Question Number | Scheme | Notes | Marks |
|---|---|---|---|
| **7.** | $y = 3x^2 + 6x^{\frac{1}{3}} + \dfrac{2x^3 - 7}{3\sqrt{x}}$ | | |
| | $\dfrac{2x^3-7}{3\sqrt{x}} = \dfrac{2x^3}{3\sqrt{x}} - \dfrac{7}{3\sqrt{x}} = \dfrac{2}{3}x^{\frac{5}{2}} - \dfrac{7}{3}x^{-\frac{1}{2}}$ | Attempts to split the fraction into 2 terms and obtains either $\alpha x^{\frac{5}{2}}$ or $\beta x^{-\frac{1}{2}}$. This may be implied by a correct power of $x$ in their differentiation of one of these terms. But beware of $\beta x^{-\frac{1}{2}}$ coming from $\dfrac{2x^3-7}{3\sqrt{x}} = 2x^3 - 7 + 3x^{-\frac{1}{2}}$ | M1 |
| | $x^n \to x^{n-1}$ | Differentiates by reducing power by one for any of their powers of $x$ | M1 |
| | $\left(\dfrac{dy}{dx} =\right)\ 6x + 2x^{-\frac{2}{3}} + \dfrac{5}{3}x^{\frac{3}{2}} + \dfrac{7}{6}x^{-\frac{3}{2}}$ | A1: $6x$. Do not accept $6x^1$. Depends on second M mark only. Award when first seen and isw.<br>A1: $2x^{-\frac{2}{3}}$. Must be simplified so do not accept e.g. $\dfrac{2}{1}x^{-\frac{2}{3}}$ but allow $\dfrac{2}{\sqrt[3]{x^2}}$. Depends on second M mark only. Award when first seen and isw.<br>A1: $\dfrac{5}{3}x^{\frac{3}{2}}$. Must be simplified but allow e.g. $1\dfrac{2}{3}x^{1.5}$ or e.g. $\dfrac{5}{3}\sqrt{x^3}$. Award when first seen and isw.<br>A1: $\dfrac{7}{6}x^{-\frac{3}{2}}$. Must be simplified but allow e.g. $1\dfrac{1}{6}x^{-1\frac{1}{2}}$ or e.g. $\dfrac{7}{6\sqrt{x^3}}$. Award when first seen and isw. | A1A1A1A1 |
| | **In an otherwise <u>fully correct solution</u>, penalise the presence of + c by deducting the final A1** | | |
| | | | **[6]** |
| | **Use of Quotient Rule: First M1 and final A1A1 (Other marks as above)** | | |
| | $\dfrac{d\left(\dfrac{2x^3-7}{3\sqrt{x}}\right)}{dx} = \dfrac{3\sqrt{x}\left(6x^2\right) - \left(2x^3-7\right)\frac{3}{2}x^{-\frac{1}{2}}}{\left(3\sqrt{x}\right)^2}$ | Uses **<u>correct</u>** quotient rule | M1 |
| | $= \dfrac{10x^{\frac{5}{2}} + 7x^{-\frac{1}{2}}}{6x}$ | A1: Correct first term of numerator and correct denominator<br>A1: All correct as simplified as shown | A1A1 |
| | So $\dfrac{dy}{dx} = 6x + 2x^{-\frac{2}{3}} + \dfrac{10x^{\frac{5}{2}} + 7x^{-\frac{1}{2}}}{6x}$ scores full marks | | |
| | | | **6 marks** |

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**8.** The straight line with equation $y = 3x - 7$ does not cross or touch the curve with equation $y = 2px^2 - 6px + 4p$, where $p$ is a constant.

(a) Show that $4p^2 - 20p + 9 < 0$

**(4)**

(b) Hence find the set of possible values of $p$.

**(4)**

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| Question Number | Scheme | Notes | Marks |
|---|---|---|---|
| **8.**(a) | $2px^2-6px+4p"="3x-7$ or $y=2p\left(\frac{y+7}{3}\right)^2-6p\left(\frac{y+7}{3}\right)+4p$ | **Either:** Compares the given quadratic expression with the given linear expression using <, >, =, ≠ (May be implied) **or** Rearranges $y = 3x - 7$ to make $x$ the subject and substitutes into the given quadratic | M1 |
| | **Examples** $2px^2-6px+4p-3x+7(=0)$, $-2px^2+6px-4p+3x-7(=0)$ $2p\left(\frac{y+7}{3}\right)^2-6p\left(\frac{y+7}{3}\right)+4p-y(=0)$, $2py^2+(10p-9)y+8p(=0)$ $y=2px^2-6px+4p-3x+7$ | | dM1 |
| | Moves all the terms to one side allowing sign errors only. Ignore > 0, < 0, = 0 etc. **The terms do not need to be collected. Dependent on the first method mark.** | | |
| | E.g. $b^2-4ac=(-6p-3)^2-4(2p)(4p+7)$ $b^2-4ac=(10p-9)^2-4(2p)(8p)$ | Attempts to use $b^2-4ac$ with their $a$, $b$ and $c$ where $a=\pm 2p$, $b=\pm(-6p\pm 3)$ and $c=\pm(4p\pm 7)$ or for the quadratic in $y$, $a=\pm 2p$, $b=\pm(10p\pm 9)$ and $c=\pm 8p$. This could be as part of the quadratic formula or as $b^2<4ac$ or as $b^2>4ac$ or as $\sqrt{b^2-4ac}$ etc. If it is part of the quadratic formula only look for use of $b^2-4ac$. There must be no $x$'s or $y$'s. **Dependent on both method marks.** | ddM1 |
| | $4p^2-20p+9<0$ * | Obtains printed answer with **no errors** seen (Allow $0>4p^2-20p+9$) **but this** < 0 must been seen at some stage before the last line. | A1* |
| | | | **[4]** |
| (b) | $(2p-9)(2p-1)=0\Rightarrow p=...$ to obtain $p=$ | Attempt to solve the **given** quadratic to find 2 values for $p$. See general guidance. | M1 |
| | $p=\frac{9}{2},\ \frac{1}{2}$ | Both correct. May be implied by e.g. $p<\frac{9}{2}$, $p<\frac{1}{2}$. Allow equivalent values e.g. 4.5, $\frac{36}{8}$, 0.5 etc. If they use the quadratic formula allow $\frac{20\pm 16}{8}$ for this mark but not $\sqrt{256}$ for 16 and allow e.g. $\frac{5}{2}\pm 2$ if they complete the square. | A1 |
| | $\frac{1}{2}<p<4\frac{1}{2}$ Allow equivalent values e.g. $\frac{36}{8}$ for $4\frac{1}{2}$ | M1: Chooses 'inside' region i.e. Lower Limit < $p$ < Upper Limit or e.g. Lower Limit ≤ $p$ ≤ Upper Limit<br>A1: Allow $p\in(\frac{1}{2},4\frac{1}{2})$ or just $(\frac{1}{2},4\frac{1}{2})$ and allow $p>\frac{1}{2}$ **and** $p<4\frac{1}{2}$ and $4\frac{1}{2}>p>\frac{1}{2}$ but $p>\frac{1}{2}$, $p<4\frac{1}{2}$ scores M1A0 $\frac{1}{2}>p>4\frac{1}{2}$ scores M0A0 | M1A1 |
| | **Allow working in terms of *x* in (b) but the answer must be in terms of *p* for the final A mark.** | | **[4]** |
| | | | **8 marks** |

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**9.** On John's 10th birthday he received the first of an annual birthday gift of money from his uncle. This first gift was £60 and on each subsequent birthday the gift was £15 more than the year before. The amounts of these gifts form an arithmetic sequence.

(a) Show that, immediately after his 12th birthday, the total of these gifts was £225 **(1)**

(b) Find the amount that John received from his uncle as a birthday gift on his 18th birthday. **(2)**

(c) Find the total of these birthday gifts that John had received from his uncle up to and including his 21st birthday. **(3)**

When John had received $n$ of these birthday gifts, the total money that he had received from these gifts was £3375

(d) Show that $n^2 + 7n = 25 \times 18$ **(3)**

(e) Find the value of $n$, when he had received £3375 in total, and so determine John's age at this time. **(2)**

| Question Number | Scheme | Notes | Marks |
|---|---|---|---|
| **9.(a)** | John; arithmetic series, $a = 60$, $d = 15$. | | |
| | $60 + 75 + 90 = 225^*$ or $S_3 = \frac{3}{2}\left(120 + (3-1)(15)\right) = 225^*$ | Finds and adds the first 3 terms or uses sum of 3 terms of an AP and obtains the printed answer, with no errors. | B1 * |
| | **Beware:** **The 12th term of the sequence is 225 also so look out for** $60 + (12-1)\times 15 = 225$. **This is B0.** | | |
| | | | **[1]** |
| **(b)** | $t_9 = 60 + (n-1)15 = (£)180$ | M1: Uses $60 + (n-1)15$ with $n = 8$ or 9<br>A1: (£)180 | M1 A1 |
| | **Listing:** M1: Uses $a = 60$ and $d = 15$ to select the 8th or 9th term (allow arithmetic slips)<br>A1: (£)180<br>(Special case (£)165 **only** scores M1A0) | | |
| | | | **[2]** |
| **(c)** | $S_n = \frac{n}{2}\left(120 + (n-1)(15)\right)$ or $S_n = \frac{n}{2}\left(60 + 60 + (n-1)(15)\right)$ | Uses correct formula for sum of $n$ terms with $a = 60$ and $d = 15$ (must be a correct formula but ignore the value they use for $n$ or could be in terms of $n$) | M1 |
| | $S_n = \frac{12}{2}\left(120 + (12-1)(15)\right)$ | Correct numerical expression | A1 |
| | $= (£)1710$ | cao | A1 |
| | **Listing:** M1: Uses $a = 60$ and $d = 15$ and finds the sum of at least 12 terms (allow arithmetic slips)<br>A2: (£)1710 | | |
| | | | **[3]** |
| **(d)** | $3375 = \frac{n}{2}\left(120 + (n-1)(15)\right)$ | Uses correct formula for sum of $n$ terms with $a = 60$, $d = 15$ and puts $= 3375$ | M1 |
| | $6750 = 15n\left(8 + (n-1)\right) \Rightarrow 15n^2 + 105n = 6750$ | **Correct three term** quadratic. E.g. $6750 = 105n + 15n^2$, $3375 = \frac{15}{2}n^2 + \frac{105}{2}n$<br>This may be implied by equations such as $6750 = 15n(n+7)$ or $3375 = \frac{15}{2}(n^2 + 7n)$ | A1 |
| | $n^2 + 7n = 25 \times 18^*$ | Achieves the printed answer with no errors but must see the 450 or 450 in factorised form or e.g. 6750, 3375 in factorised form i.e. an intermediate step. | A1* |
| | | | **[3]** |
| **(e)** | $n = 18 \Rightarrow$ Aged 27 | M1: Attempts to solve the given quadratic or states $n = 18$<br>A1: Age = 27 or just 27 | M1 A1 |
| | Age = 27 only scores both marks (i.e. $n = 18$ need not be seen) | | |
| | **Note that (e) is not hence so allow valid attempts to solve the given equation for M1** | | |
| | | | **[2]** |
| | | | **11 marks** |

| $n$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| $u_n$ | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 |
| $S_n$ | 60 | 135 | 225 | 330 | 450 | 585 | 735 | 900 | 1080 |
| Age | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |

| $n$ | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|
| $u_n$ | 195 | 210 | 225 | 240 | 255 | 270 | 285 | 300 | 315 |
| $S_n$ | 1275 | 1485 | 1710 | 1950 | 2205 | 2475 | 2760 | 3060 | 3375 |
| Age | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |

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**10.**

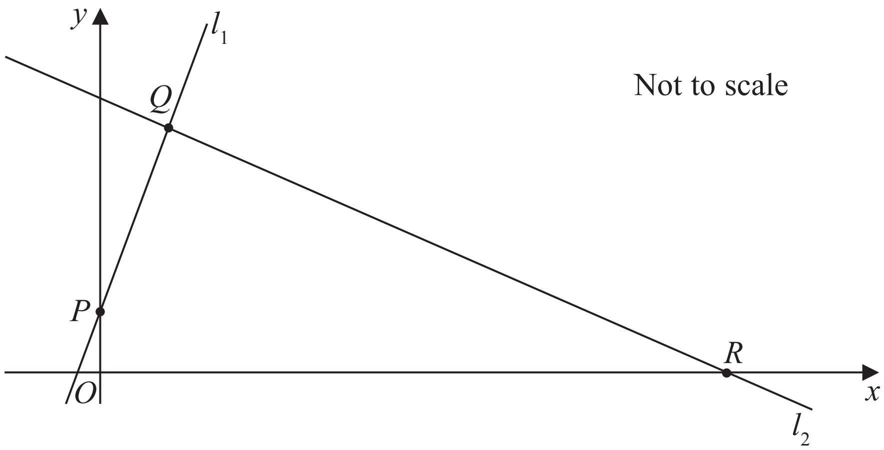


**Figure 2**

The points $P$ (0, 2) and $Q$ (3, 7) lie on the line $l_1$, as shown in Figure 2.

The line $l_2$ is perpendicular to $l_1$, passes through $Q$ and crosses the $x$-axis at the point $R$, as shown in Figure 2.

Find

(a) an equation for $l_2$, giving your answer in the form $ax + by + c = 0$, where $a$, $b$ and $c$ are integers,

**(5)**

(b) the exact coordinates of $R$,

**(2)**

(c) the exact area of the quadrilateral $ORQP$, where $O$ is the origin.

**(5)**

| Question Number | Scheme | Notes | Marks |
|---|---|---|---|
| **10.(a)** | $l_1$ : passes through (0, 2) and (3, 7) $l_2$ : goes through (3, 7) and is perpendicular to $l_1$ | | |
| | Gradient of $l_1$ is $\frac{7-2}{3-0}\left(=\frac{5}{3}\right)$ | $m(l_1)=\frac{7-2}{3-0}$. Allow un-simplified. May be implied. | B1 |
| | $m(l_2)=-1\div their\ \frac{5}{3}$ | Correct application of perpendicular gradient rule | M1 |
| | $y-7="-\frac{3}{5}"(x-3)$ or $y="-\frac{3}{5}"x+c,\ 7="-\frac{3}{5}"(3)+c \Rightarrow c=\frac{44}{5}$ | M1: Uses $y-7=m(x-3)$ with their **changed** gradient or uses $y=mx+c$ with $(3, 7)$ and their **changed** gradient to find a value for $c$<br>A1ft: Correct ft equation for their perpendicular gradient **(this is dependent on both M marks)** | M1A1ft |
| | $3x+5y-44=0$ | Any positive or negative integer multiple. Must be seen in (a) and must include "= 0". | A1 |
| | | | **[5]** |
| (b) | When $y=0$ $x=\frac{44}{3}$ | M1: Puts $y = 0$ and finds a value for $x$ from their equation<br>A1: $x=\frac{44}{3}\left(\text{or } 14\frac{2}{3} \text{ or } 14.\dot{6}\right)$ or exact equivalent. ($y = 0$ not needed) | M1 A1 |
| | **Condone 3x – 5y – 44 = 0 only leading to the correct answer and condone coordinates written as (0, 44/3) but allow recovery in (c)** | | |
| | | ` | **[2]** |
| (c) | **GENERAL APPROACH:** | | |
| | Correct attempt at finding the area of any one of the triangles or one of the trapezia but not just one rectangle. The correct pair of 'base' and 'height' must be used for a triangle and the correct formula used for a trapezium. If Pythagoras is required, then it must be used correctly with the correct end coordinates.<br>**Note that the first three marks apply to their calculated coordinates e.g. their $\frac{44}{3}$, $\frac{44}{5}$, $-\frac{6}{5}$ etc. But the given coordinates must be correct e.g. (0, 2) and (3, 7).** | | M1 |
| | A correct numerical **expression** for the area of one **triangle** or one **trapezium** for **their coordinates**. | | A1ft |
| | Combines the correct areas together correctly for their chosen "way". Note that if correct numerical expressions for areas have been incorrectly simplified before combining them, then this M1 may still be given. **Dependent on the first method mark.** | | dM1 |
| | Correct numerical expression for the area of *ORQP*. **The expressions must be fully correct for this mark i.e. no follow through.** | | A1 |
| | Correct exact area e.g. $54\frac{1}{3}$, $\frac{163}{3}$, $\frac{326}{6}$, $54.\dot{3}$ or any exact equivalent | | A1 |

| | **Shape** | **Vertices** | **Numerical Expression** | **Exact Area** | |
|---|---|---|---|---|---|
| | Triangle | *TRQ* | $\frac{1}{2}\times 7\times\left(\frac{44}{3}-3\right)$ | $\frac{245}{6}$ | |
| | Triangle | *SPO* | $\frac{1}{2}\times\frac{6}{5}\times 2$ | $\frac{6}{5}$ | |
| | Triangle | *PWQ* | $\frac{1}{2}\times\left(\frac{44}{5}-2\right)\times 3$ | $\frac{51}{5}$ | |
| | Triangle | *PVQ* | $\frac{1}{2}\times(7-2)\times 3$ | $\frac{15}{2}$ | |

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**11.** The curve $C$ has equation $y = 2x^3 + kx^2 + 5x + 6$, where $k$ is a constant.

(a) Find $\frac{dy}{dx}$

**(2)**

The point $P$, where $x = -2$, lies on $C$.

The tangent to $C$ at the point $P$ is parallel to the line with equation $2y - 17x - 1 = 0$

Find

(b) the value of $k$,

**(4)**

(c) the value of the $y$ coordinate of $P$,

**(2)**

(d) the equation of the tangent to $C$ at $P$, giving your answer in the form $ax + by + c = 0$, where $a$, $b$ and $c$ are integers.

**(2)**

| Question Number | Scheme | | Marks |
|---|---|---|---|
| **11. (a)** | $y = 2x^3 + kx^2 + 5x + 6$ | | |
| | $\left(\frac{dy}{dx} = \right) 6x^2 + 2kx + 5$ | M1: $x^n \to x^{n-1}$ for one of the terms including $6 \to 0$<br>A1: Correct derivative | M1 A1 |
| | | | **[2]** |
| **(b)** | Gradient of given line is $\frac{17}{2}$ | Uses or states $\frac{17}{2}$ or equivalent e.g. 8.5. Must be stated or used in (b) and not just seen as part of $y = \frac{17}{2}x + \frac{1}{2}$. | B1 |
| | $\left(\frac{dy}{dx}\right)_{x=-2} = 6(-2)^2 + 2k(-2) + 5$ | Substitutes $x = -2$ into their derivative **(not the curve)** | M1 |
| | $"24 - 4k + 5" = "\frac{17}{2}" \Rightarrow k = \frac{41}{8}$ | dM1: Puts their expression = their $\frac{17}{2}$ (Allow BOD for 17 or -17 but **not** the normal gradient) and solves to obtain a value for $k$. **Dependent on the previous method mark**.<br>A1: $\frac{41}{8}$ or $5\frac{1}{8}$ or 5.125 | dM1 A1 |
| | **Note:**<br>$6x^2 + 2kx + 5 = \frac{17}{2}x + \frac{1}{2}$ scores no marks on its own but may score the first M mark if they substitute $x$ = -2 into the lhs. If they rearrange this equation and then substitute $x$ = -2, this scores no marks. | | |
| | | | **[4]** |
| **(c)** | $y = -16 + 4k - 10 + 6 = 4"k" - 20 = \frac{1}{2}$ | M1: Substitutes $x = -2$ and their numerical $k$ into $y = \ldots$<br>A1: $y = \frac{1}{2}$ | M1 A1 |
| | **Allow the marks for part (c) to be scored in part (b).** | | |
| | | | **[2]** |
| **(d)** | $y - "\frac{1}{2}" = "\frac{17}{2}"(x - {}^-2) \Rightarrow -17x + 2y - 35 = 0$<br>or<br>$y = "\frac{17}{2}"x + c \Rightarrow c = \ldots \Rightarrow -17x + 2y - 35 = 0$<br>or<br>$2y - 17x = 1 + 34 \Rightarrow -17x + 2y - 35 = 0$ | M1: Correct attempt at linear equation with their 8.5 gradient (not the normal gradient) using $x$ = -2 and their $\frac{1}{2}$<br>A1: cao (allow any integer multiple) | M1 A1 |
| | | | **[2]** |
| | | | **10 marks** |